TELESCOPING TABLE

DESCRIPTION

The present invention relates to the diagnostic imaging systems and methods. It finds particular application in conjunction with multi-modality systems such as the GEMINI™ PET-CT system manufactured by Philips. It will be appreciated that the invention is also applicable to the combination of SPECT and CT scanners, and the other scanner combinations.

In multi-modality tomographic systems, two or more different imaging modalities are used to locate or measure different constituents in the object space. In the PET-CT system, the PET creates images of high metabolic activity in the body, rather than creating images of surrounding anatomy. CT scans allow doctors to see the internal structures within the human body. Before having a PET-CT scan, the subject receives a dose of a radiopharmaceutical. The pharmaceutical concentrates in the blood, a particular organ, or region and causes radiation to be emitted from this organ or region. During the scan, tracings of the emitted radiation are detected by the system creating an image of the distribution of the radiopharmaceutical in the subject. The image can show the circulatory system and/or the relative absorption of the radiopharmaceutical in various regions or organs. Integration of the anatomical data from the CT scan with the metabolic data from the PET scan in the PET-CT image gives physicians visual information to determine if disease is present, the location and extent of disease and track how rapidly it is spreading as well as relating the PET image to the subject's physiology. The PET-CT system is particularly helpful in difficult-to-treat regions (e.g. head & neck area, mediastinum, postsurgical abdomen) and localization of the treatment area for the subjects receiving radiation therapy or chemotherapy.

The multi-modality imaging requires the subject support table be slidable horizontally into the first and the second modality. Extending the pallet a sufficient distance to span both modalities causes problems either with large table or deflection of subject pallet. Typically, the subject pallet is supported at front and rear ends by support structures. As the pallet starts extending to a fully extended position, its support changes from being supported on two ends to being supported on one end. In the beginning of the motion, the pallet looks as a straight line. As it is extended into the first modality, it is

slightly bent. The more the pallet extends, the more it bends, causing different deflection and subject positioning in the second modality compared to the first one and introducing an error in the orientation of detectors with respect to the subject.

There is a need for a subject support table that has a constant deflection during imaging in both modalities with a safe retraction technique, which allows the subject pallet to be retracted in an efficient manner during emergency situations. The present invention provides a new and improved imaging apparatus and method which overcomes the above-referenced problems and others.

In accordance with one aspect of the present invention, a diagnostic imaging system includes a first diagnostic scanner of a first modality having a subject receiving bore. A second diagnostic scanner of a second modality having a subject receiving bore is disposed adjacent the first diagnostic scanner with the second modality subject receiving bore being aligned with the first modality subject receiving bore. An intermediate support is disposed between the first and second diagnostic scanners. A telescoping table system including a base is disposed adjacent the first diagnostic scanner for imaging a subject in at least the first modality and the second modality. An intermediate pallet having a tip and a trailing edge is mounted to the base for longitudinal movement between at least a retracted position and an extended position with the tip extending outward from the base. A subject pallet has bearing supports mounted adjacent subject pallet trailing edge such that the subject pallet is cantilevered therefrom. The bearing supports are mounted to the intermediate pallet for longitudinal movement therealong. The subject pallet moves through the first modality subject receiving bore. The intermediate pallet extends through the first modality subject receiving bore to the intermediate support. The subject pallet moves along the intermediate pallet through the second modality subject receiving bore.

In accordance with another aspect of the present invention, a method is disclosed. An intermediate pallet is movably mounted to a base for longitudinal movement therealong between at least a retracted position and an extended position. A subject pallet having a leading edge and a trailing edge is movably mounted on the intermediate pallet for longitudinal movement therealong with bearing supports mounted adjacent the trailing edge only such that the subject pallet is cantilevered therefrom.

One advantage of the present invention resides in stabilizing deflection of the subject pallet of the telescopic table while fully extending the subject pallet into second modality.

Another advantage of the present invention resides in improving registration in multiple modality systems.

Yet another advantage of the present invention resides in accomplishing safe retraction of the subject pallet in emergency situations.

Still further advantages and benefits of the present invention will become apparent to those of ordinary skill in the art upon reading and understanding the following detailed description of the preferred embodiments.

The invention may take form in various components and arrangements of components, and in various steps and arrangements of steps. The drawings are only for purposes of illustrating the preferred embodiments and are not to be construed as limiting the invention.

FIGURE 1 is a diagrammatic illustration of a CT-PET imaging system;

FIGURE 2A is a diagrammatic illustration of a subject support table in a retracted position;

FIGURE 2B is a diagrammatic illustration of a subject support table in a first modality start position;

FIGURE 2C is a diagrammatic illustration of a subject support table with a subject pallet extending into the first modality;

FIGURE 2D is a diagrammatic illustration of a subject support table in a second modality start position;

FIGURE 2E is a diagrammatic illustration of a subject support table with a subject pallet extending into the second modality;

FIGURE 3 is a diagrammatic illustration of a PET-CT imaging system with a subject support table extending into the second modality; and

FIGURE 4 is a mechanical drawing depicting a portion of a safety release mechanism.

With reference to FIGURE 1, a multi-modality system **10** includes a computed tomography imaging system or a first modality **12** and a nuclear imaging system or a second modality **14**. The computed tomography (CT) imaging system **12** includes a CT scanner **16** including a non-rotating gantry **18**. An x-ray tube **20** is mounted to a rotating gantry **22**. A bore **24** defines a subject receiving bore of the CT scanner **16**. An array of radiation detectors **26** is disposed on the rotating gantry **22** to receive radiation from the x-ray tube **20** after the x-rays transverse the subject receiving bore **24**. Alternatively, the array of detectors **26** may be mounted on and encircle the non-rotating gantry **18**.

The nuclear imaging system **14** preferably includes a positron emission tomography (PET) scanner **28** which is mounted on tracks **30**. Of course, SPECT and other nuclear imaging systems are also contemplated. The tracks **30** extend in parallel to a longitudinal axis of a subject support table or couch **32**, thus enabling the CT scanner **16** and PET scanner **28** to form a closed system for dual modality use or moved apart for independent operation (not shown). A moving means **34**, such as a motor and a drive, is provided to move the scanner **28** between the open and closed positions. Detectors (not shown) are arranged around a bore **36** which is aligned with the CT scanner bore **24** defining a subject receiving bore of PET scanner **28**. In the PET system, the detectors are preferably arranged in a stationery ring, although rotatable heads are also contemplated. In the SPECT system, the detectors are preferably incorporated into individual heads, which are mounted for rotational and radial movement relative to the subject.

With continuing reference to FIGURE 1, a subject is positioned on the subject support table **32** which is moved to position the subject in the CT scanner subject receiving bore **24**, where the CT image is taken. Electronic data is reconstructed into a 3D CT image by a CT reconstruction processor **38** and stored in a CT image memory **40**. Next, the subject support table **32** with the subject is moved into the PET receiving bore **36** for a 3D image to be generated by the PET scanner **28**. Electronic data is reconstructed into a PET image by a PET reconstruction processor **42** and stored in a PET image memory **44**. Optionally, the CT image is used in the nuclear image reconstruction to correct for attenuation due to bones or dense tissue.

A fusion processor or means **46** receives the both CT and PET images to combine the CT and PET image into one 3D image. A combined image is stored in a 3D combined image memory **48**. A video processor **50** retrieves the data from the 3D combined image memory **48** and processes the received data for a display on a monitor **52**.

With reference to FIGURE 2A, the subject support table **32** is shown in a collapsed or fully retracted position A that is typically used to load and unload the subject. The subject support table **32** is floor mounted by a use of two support base members or columns **60, 62**, each including drive mechanisms **64, 66** which are used to move the subject support table **32** to a higher and lower positions with respect to the floor. A main support pallet **68** is positioned substantially horizontally on upper ends **70, 72** of the columns **60, 62**. Lower ends **74, 76** of the columns **60, 62** are preferably bolted down to secure the subject support table **32** to the floor. The subject support table **32** includes an intermediate pallet **78** which is spaced above an upper surface **80** of the main support pallet **68**. A subject pallet **82**, fabricated from a radiolucent material, is positioned above an upper surface **84** of the intermediate pallet **78**. The subject pallet is preferably a stiffened carbon fiber to minimize and avoid deflection even with the heaviest subjects. The intermediate pallet **78** is supported by a static support member **86**, and first and second intermediate bearing support members **88, 90**. The static support member **86** is positioned on the main support pallet upper surface **80** about a leading edge **92** of the main support pallet **68**, to support a lower surface **94** of the intermediate pallet **78**. The first and second intermediate bearing support members **88, 90** are disposed on the intermediate pallet lower surface **94**. The second intermediate support member **90** is positioned near a trailing edge **96** of the intermediate pallet **78** for movably supporting the intermediate pallet on the main support pallet upper surface **80**. The subject pallet **82** is mounted in cantilevered fashion by subject pallet bearing support members **98** positioned on a lower surface **100** about a trailing edge **102** of the subject pallet **82** for movably supporting the subject pallet 82 on the intermediate pallet upper surface **84**. Motors **104, 106** drive the intermediate pallet **78** and the subject pallet **82** respectively to extend the subject table **32** into the first and second modalities (not shown) for imaging.

With reference to FIGURE 2B, the subject support table **32** is at a position **B**, in which both intermediate and subject pallets **78, 82** are slightly extended with respect to the main support pallet **68** and arrived at a start position of the first modality (not

shown). A tip **110** of the intermediate pallet **78** adjacent to a leading edge **112** of the intermediate pallet **78** is supported by the static support member **86**. An offset between the main pallet leading edge **92** and the intermediate pallet leading edge **112** is represented by a distance **d** which is the distance from the subject support table to the first scanner. At the position **B**, the subject pallet **82** when loaded with a maximum size subject is substantially parallel to the ground.

With reference to FIGURE 2C, the subject support table **32** is at a position **C**, in which the subject pallet **82** is fully extended into the first modality (not shown). Since the intermediate pallet **78** has not been moved, the tip **110** is still supported by the static support member **86**, which is offset from the intermediate pallet leading edge **112** by the same distance as in the position **B**, e.g. distance **d** as shown in FIGURE 2B, regardless of the degree of extension of the subject pallet into the first modality. An extended subject pallet **82** is supported by the subject support members **98** at a rear end section **114** adjacent to the subject support pallet trailing edge **102** with the same degree of cantilevering. Because the subject pallet is supported cantilevered from the support members **98**, the loaded subject pallet **82** has no more or less deflection in position **C** than in position **B**. Because the cantilevering does not change as different parts of the subject are positioned in the first scanner, the degree of deflection does not change.

With reference again to FIGURE 2B and further reference to FIGURE 2D, to image in the second scanner, the subject pallet **82** is withdrawn to the position of FIGURE 2B. Then the subject pallet **82** extends together with the intermediate pallet **78** to the position of the subject support table **32** is at a position **D**. It should be noted that because the subject table bearing blocks **98** are positioned between intermediate support blocks **88, 90**, the subject load is at the back of the intermediate pallet **78** as the two pallets move together. There is no subject load on the front end **110** of the intermediate pallet. The subject and intermediate pallets **82, 78** are extended through the first modality (not shown) and arrived at a start position of the second modality (not shown). There is no substantial offset of the intermediate pallet leading edge **112** and a leading edge **116** of the subject pallet **82**. A catcher **118** supports the intermediate pallet **78** in the extended position to carry the load that will be placed on the intermediate pallet tip **110** when the subject pallet extends. More particularly, the catcher **118** includes a motor **120** which drives an associated lift mechanism **122** to move the catcher **118** in lower and higher positions with

respect to the floor. Typically, in the positions A-C, the catcher **118** is idle and kept in a collapsed position. When the intermediate pallet **78** is fully extended, the motor **120** drives the lift mechanism **122** to extend the catcher **118** until a catcher support member **124**, positioned on an upper surface **126** about a leading edge **128** of the catcher **118** touches the intermediate pallet bottom surface **94**. Preferably, the intermediate pallet **78** is manufactured from a stiff carbon fiber to prevent deflection and maintain the intermediate pallet substantially flat with respect to the floor.

With continuing reference to FIGURE 2D and reference again to FIGURE 2C, an offset **d** between the catcher leading edge **128** and the intermediate pallet leading edge **112** is the same as the offset between the main pallet leading edge **92** and the intermediate pallet leading edge **112** in the position **C**. In this manner, the intermediate pallet is supported the same in positions **C** and **D**.

With reference to FIGURES 2E and 3, the subject support table **32** is at a position E, in which the subject pallet **82** is fully extended into the second modality **14**. Since the intermediate pallet **78** has not been moved, the intermediate pallet tip **110** is still supported by the catcher support member **124** which is offset from the intermediate pallet leading edge **112** by the same distance **d** as in the positions B-D discussed above. Thus, the intermediate pallet receives the same loading and undergoes the same deflection, if any, in positions **C** and **E**. An extended subject pallet **82** is supported by the subject support members **98** at the subject pallet rear end section **114** in the same cantilevered fashion. Due to the cantilever mounting of the subject pallet, there is no change in the deflection of the subject pallet regardless which portion of the subject is positioned in the second scanner.

With continuing reference to FIGURE 2E and reference again to FIGURE 2C, during imaging in the second modality, the loaded subject pallet **82** is deflected by the same amount, as it was deflected in position **C** during imaging in the first modality. The constant deflection of the subject pallet **82** in both modalities ensures more reliable registration between the modalities as the subject orientation with respect to the detectors stays consistent.

To retract the subject pallet, the reverse procedure is followed. Specifically, the subject pallet moves from position **E** to position **D**. Then, both pallets move together from position **D** through position **B** to position **A**, at which position the subject is unloaded.

With continuing reference to FIGURE 3 and further reference to FIGURE 4, during normal operation the electric power is ON. To permit the movement of the pallets **78, 82**, a solenoid (not shown) rotates a spline shaft **152** against a spring bias to lift a locking lever **148** out of a sprocket **144** and move shaft lever **142** out of path of latch **140**. Lifting the locking lever **148** out of sprocket **144** allows a leadscrew **146** to be turned to move the intermediate pallet **78** between positions **B** and **D**. Software ensures that the intermediate pallet **78** cannot be driven if the subject pallet **82** is extended to the positions **C** and **E**. A safety release or extraction mechanism **150** ensures that the subject pallet **82** can be retracted manually from the fully extended position **E** quickly back into the collapsed position **A** in a safe sequence. The subject pallet **82** is fully retracted before the intermediate pallet **78** is retracted as discussed in greater detail below. During the imaging in the second modality **14**, e.g. position **E**, the intermediate pallet **78** is fully extended and the subject pallet is partially to fully extended. The intermediate pallet **78** is supported by the catcher **118**. In an emergency, e.g. when the electric power or computer control is lost, the solenoid (not shown) relaxes allowing the spline shaft **152** to be rotated by a spring bias allowing locking lever **148** to engage sprocket **144** and allows lever **142** to move into the path of latch **140**. The attendant pushes or pulls the subject pallet rearward. The interaction of the leadscrew locking lever **148** and the leadscrew sprocket **144** prevents the leadscrew **146** from turning, ensuring that the intermediate pallet **78** cannot move. When the subject pallet **82** is brought to the fully retracted position **D** by medical personnel, the latch **140** disposed on the subject pallet **82** latches onto a shaft lever **142** locking the subject pallet **82** into the retracted position. When the subject pallet **82** is brought manually substantially to the fully retracted position **D**, the subject latch **140** includes a ramp that pushes on the shaft lever **142**, forcing the shaft **152** to rotate against a spring bias. When the shaft **152** rotates, it disengages the leadscrew locking lever **148** from the leadscrew sprocket **144**, unlocking the intermediate pallet leadscrew **146**. Once the leadscrew **146** can turn, continued manual rearward pressure moves the intermediate pallet **78** into the retracted position.

Because there is substantially no load on the forward end of the intermediate pallet in position **D** and because the support block **124** was raised to just touch the underside of the intermediate pallet, the intermediate pallet **78** slides easily off the support block **124**, even without lowering the catcher **118**. In this manner, an attendant

can manually push or pull the subject quickly to the unloading position A in a continuous motion, without computer control and/or electric power. With computer control and electric power present, the pallets can be retracted with motor power.

The invention has been described with reference to the preferred embodiments. Modifications and alterations may occur to others upon a reading and understanding of the preceding detailed description. It is intended that the invention be constructed as including all such modifications and alterations insofar as they come within the scope of the appended claims or the equivalents thereof.